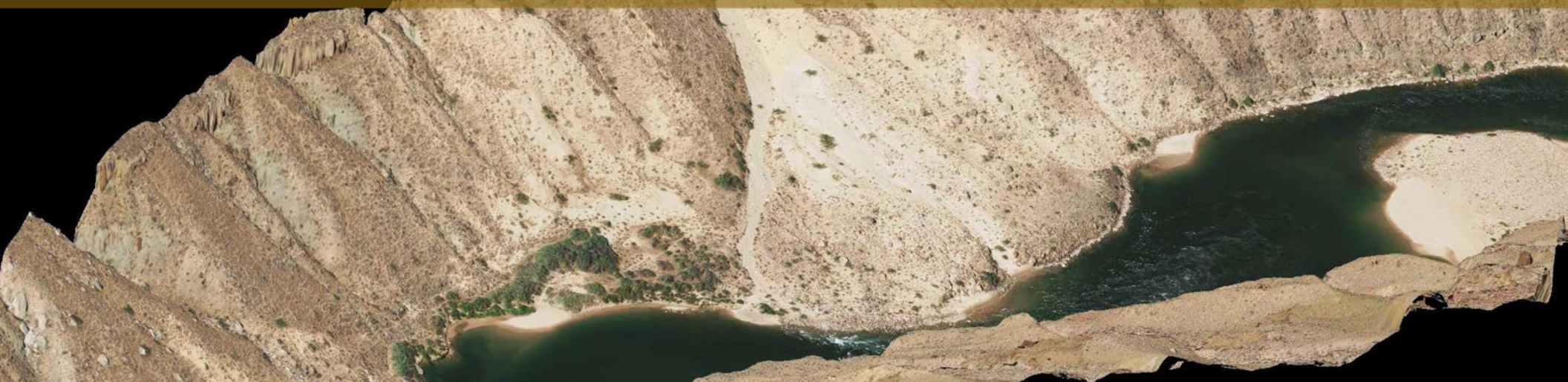




Project L: Overflight Remote Sensing

*in support of
Long-Term Monitoring and LTEMP*



 Southwest Biological
Science Center
Grand Canyon Monitoring and Research Center
U.S. Geological Survey
Department of the Interior.

Joshua Caster, Joel B. Sankey, Nathaniel Bransky and David Dean

GCDAMP Annual Reporting Meeting

Feb 4, 2026



This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.

GCMRC Triennial Workplan (TWP) Project L



Project Element L.1. Analysis and Interpretation of Overflight Remote Sensing Data

- Imagery and derivative data products from overflight remote sensing are used either directly or indirectly by every science project proposed in the TWP to address every resource goal of the LTEMP



2021 Orthomosaic Imagery



2021 Digital Surface Model

Little Colorado River Confluence

950 m

800 m

Project L Overflight Remote Sensing Products



USGS ScienceBase-Catalog

ScienceBase Catalog → USGS Southwest Biological ... → SBSC Public Data, Metadata... → 2024 → Four Band Multispectral Hig...

Four Band Multispectral High Resolution Image Mosaic of the Colorado River Corridor, Arizona - 2021

Four Band Image Mosaic of the Colorado River Corridor in Arizona--2021, including Accuracy Assessment Data

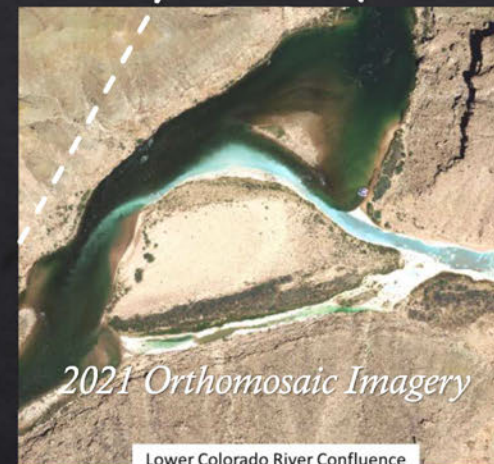
Dates

Publication Date:	2024-01-31
Start Date:	2021-05-29
End Date:	2021-06-04

Citation

Sankey, J.B., Bransky, N., Pigue, L., Kohl, K., and Gushue, T.M., 2024. Four Band Image Mosaic of the Colorado River Corridor in Arizona--2021, including Accuracy Assessment Data. U.S. Geological Survey data release. <https://doi.org/10.5066/99BBGN6G>

Map »



ScienceBase Catalog → USGS Southwest Biological ... → SBSC Public Data, Metadata... → 2025 → Digital elevation model (DE...

Digital elevation model (DEM) and digital surface model (DSM) data for the Colorado River corridor in Grand Canyon National Park and Glen Canyon National Recreation Area (2002, 2009, 2013 and 2021), including accuracy assessment data

1-meter spatial resolution digital elevation models (DEMs) digital surface models (DSMs) for Zone 1 to Zone 15

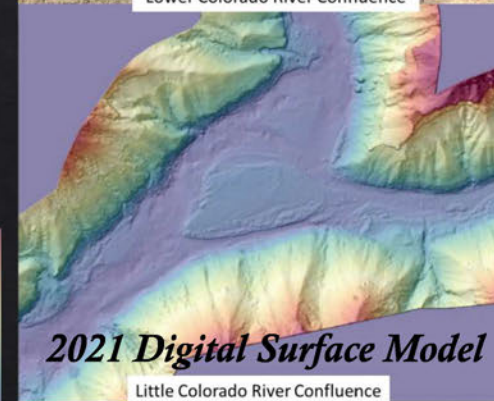
Dates

Publication Date:	2025-01-23
Time Period:	2002
Time Period:	2009
Time Period:	2013
Time Period:	2021

Citation

Sankey, J.B., Bransky, N.B., Kohl, K.A., Gushue, T.M., Bedford, A.F., and Durning, L.E., 2025. Digital elevation model (DEM) and digital surface model (DSM) data for the Colorado River corridor in Grand Canyon National Park and Glen Canyon National Recreation Area (2002, 2009, 2013 and 2021), including accuracy assessment data. U.S. Geological Survey data release. <https://doi.org/10.5066/99BBGN6G>

Map »



All data published and publicly accessible

Project L Goals

Project Element L.1. Analysis and Interpretation of Overflight Remote Sensing Data

Science Questions (FY25 – 27 TWP):

- How have the system-wide area and volume of high elevation sand (part of LTEMP performance Metric 7) changed?
- Can system-wide remote sensing measurements provide a comprehensive metric of dam-related changes by integrating,
 1. Riparian vegetation cover (LTEMP performance Metric 11.1)
 2. Active channel widths (Project C.4)
 3. Other land covers
 4. Management activities, climate, or other environmental factors in the ecosystem



Project L Science Activities

Land cover classification for 2021 imagery

♥ ~8,000 ft/s discharge stage (steady dam release during May 2021 imagery)

◇ Total riparian cover

◇ Sand and other river sediment



Project L Science Activities

Land cover classification for 2021 imagery

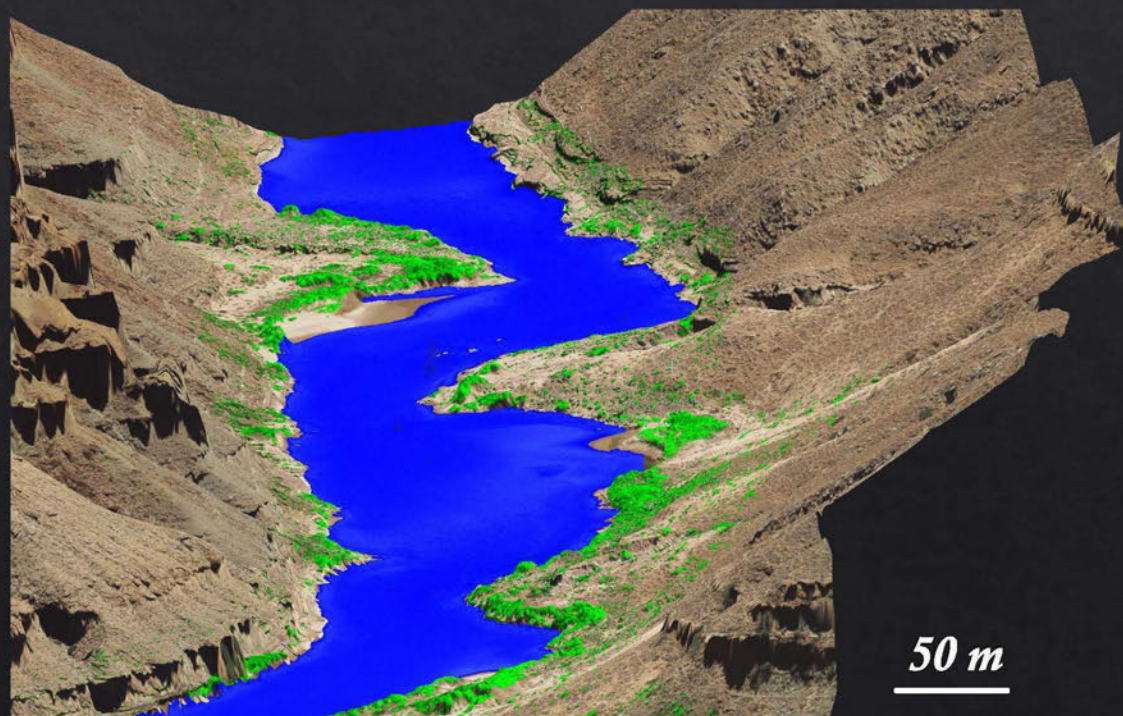
- ♥ ~8,000 ft/s discharge stage (steady dam release during May 2021 imagery)
- ♥ Total riparian cover
- ◇ Sand and other river sediment

2021 Vegetation

2021 Discharge

Glen Canyon to

Pierce Ferry



50 m

Project L Science Activities

Land cover classification for 2021 imagery

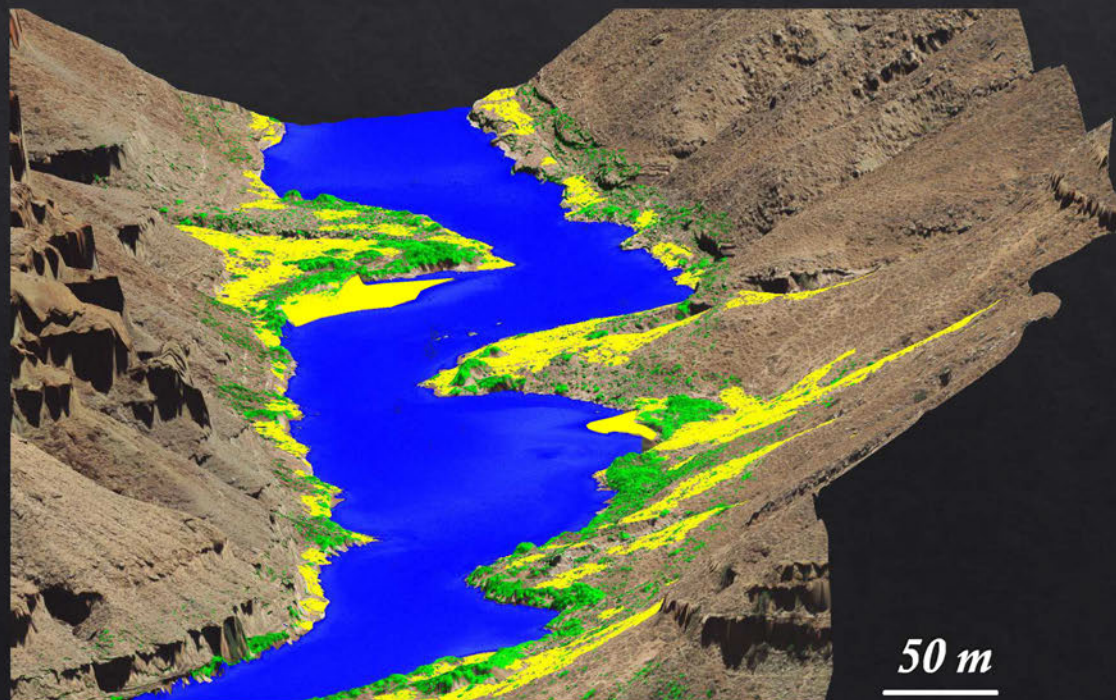
- ♥ ~8,000 ft/s discharge stage (steady dam release during May 2021 imagery)
- ✓ Total riparian cover
- ✓ Sand and other river sediment

2021 River Sediment

2021 Vegetation

2021 Discharge

*Glen Canyon to
Bright Angel*



50 m

Project L Science Activities

Change detection for Riparian Vegetation

(Associated with LTEMP performance Metric 11.1)

Classified vegetation is segmented into previously defined hydrologic zones and river reaches

Zones by modeled flow

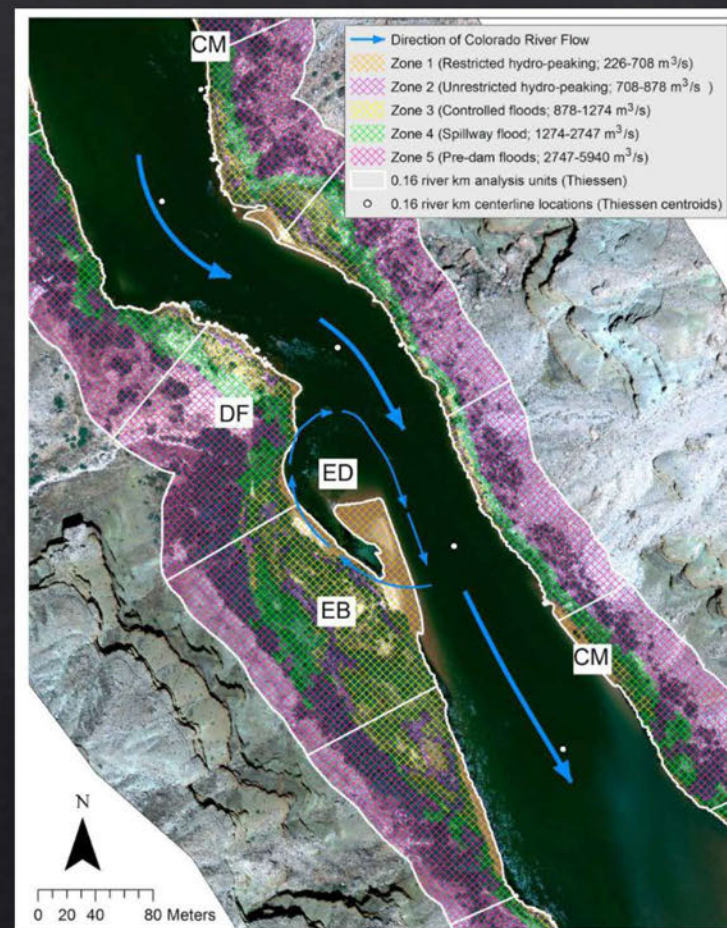
8,000 – 25,000 cfs

25,000 – 31,000 cfs

31,000 – 45,000 cfs

45,000 – 97,000 cfs

97,000 – 210,000 cfs



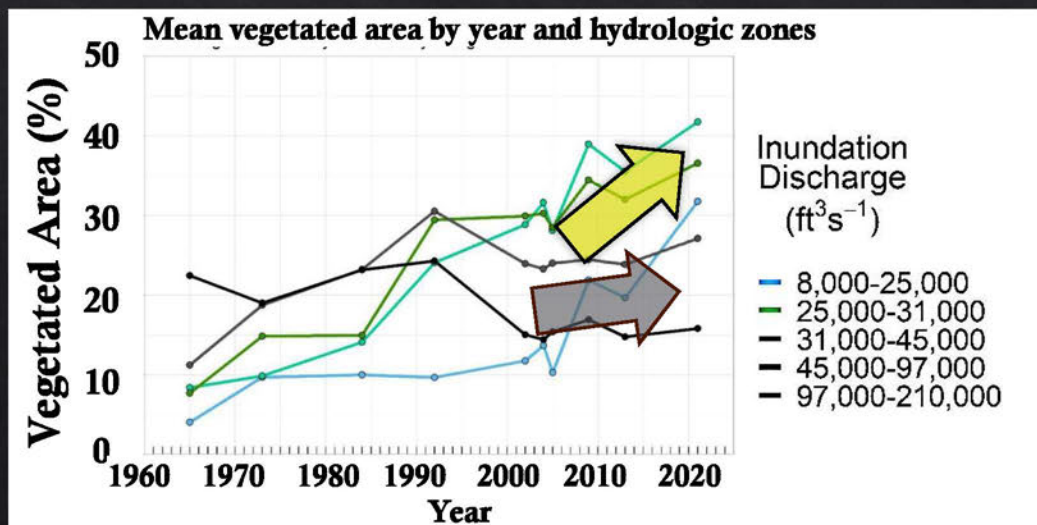
Sankey and others, 2015

Project L Science Activities

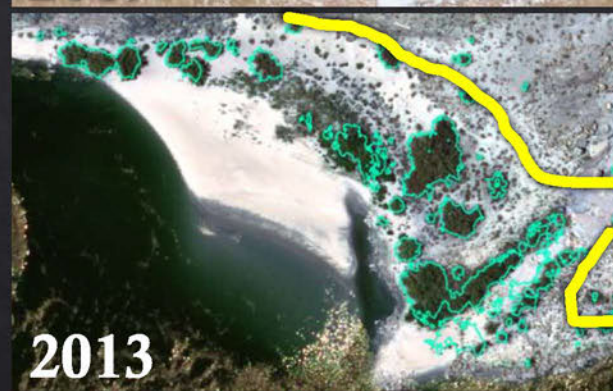
Change detection for Riparian Vegetation

(Associated with LTEMP performance Metric 11.1)

Vegetation area is summarized within defined zones and reaches



2002  Vegetation Cover





Glen Canyon Dam



Glen Canyon Dam

Project L Next Steps and Timeline

Fiscal Year	Project Element L.1 Science Activities
2025	<ul style="list-style-type: none"> • Produce CRe landcover classification maps derived from analysis of the orthomosaic of high-resolution multispectral imagery (Sankey and others, 2024; 2025). <ul style="list-style-type: none"> ○ 8,000 ft³/s low-flow river channel ✓ ○ total riparian vegetation cover ✓ ○ sand and other river sediment ✓
2026	<ul style="list-style-type: none"> • Complete change detection analysis of total riparian vegetation cover from 2021 and previous overflight classification maps. • Use riparian vegetation cover in analyses of changes in channel width (Project C.4)
2027	<ul style="list-style-type: none"> • Conduct DSM change detection analysis for a continuous section of the river corridor. <ul style="list-style-type: none"> ○ Calculate and report on LTEMP Performance Metric for High Elevation Sand > 25,000 CFS stage that is deposited by HFEs.



Glen Canyon Dam



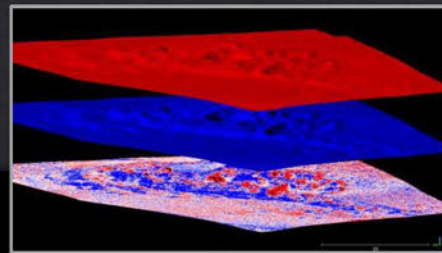
Glen Canyon Dam

Project L Next Steps and Timeline

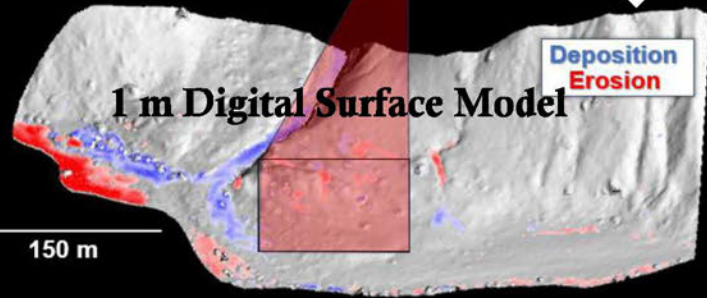
Fiscal Year	Project Element L.1 Science Activities
2025	<ul style="list-style-type: none"> • Produce CRe landcover classification maps derived from analysis of the orthomosaic of high-resolution multispectral imagery (Sankey and others, 2024; 2025). <ul style="list-style-type: none"> ○ 8,000 ft³/s low-flow river channel ✓ ○ total riparian vegetation cover ✓ ○ sand and other river sediment ✓
2026	<ul style="list-style-type: none"> • Complete change detection analysis of total riparian vegetation cover from 2021 and previous overflight classification maps ✓ <i>Discussed further as LTEMP Performance Metric 11.1</i> • Use riparian vegetation cover in analyses of changes in channel width (Project C.4) – IN PROGRESS
2027	<ul style="list-style-type: none"> • Conduct DSM change detection analysis for a continuous section of the river corridor. <ul style="list-style-type: none"> ○ Calculate and report on LTEMP Performance Metric for High Elevation Sand > 25,000 CFS stage that is deposited by HFEs.

Project L Science Activities

DSM change detection analysis for a continuous section of the river corridor



Overflight
Photogrammetry



Successful proof-of-
concept examples for
“very” high elevation
aeolian sand

Geomorphology 447 (2024) 109021

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorphology

Do topographic changes tell us about variability in aeolian sediment transport and dune mobility? Analysis of monthly to decadal surface changes in a partially vegetated and biocrust covered dunefield

Joshua Caster^{a,b,c}, Joel B. Sankey^a, Temuulen Ts. Sankey^a, Alan Kasprak^{a,d}, Matthew A. Bowker^{a,e}, Taylor Joyal^a

^a U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center, Flagstaff, AZ, USA
^b Northern Arizona University, School of Earth and Sustainability, Flagstaff, AZ, USA
^c Northern Arizona University, School of Informatics, Computing, and Cyber Systems, Flagstaff, AZ, USA
^d Fort Lewis College, Department of Geosciences and Four Corners Water Center, Durango, CO, USA
^e Northern Arizona University, School of Forestry, Flagstaff, AZ, USA
^f Northern Arizona University, Center for Ecosystem Science and Society, Flagstaff, AZ, USA

ARTICLE INFO

ABSTRACT

Fluvially-sourced sediment supply and climate modulate morphodynamics and state transitions in bistable aeolian dunefields

Joshua Caster^{1,2}, Joel B Sankey¹, Temuulen Sankey¹, Taylor Joyal¹, Matthew A. Bowker^{4,5}

¹U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and Research Center
²Northern Arizona University, School of Earth and Sustainability
³Northern Arizona University, School of Informatics, Computing, and Cyber Systems
⁴Northern Arizona University, School of Forestry
⁵Northern Arizona University, Center for Ecosystem Science and Society

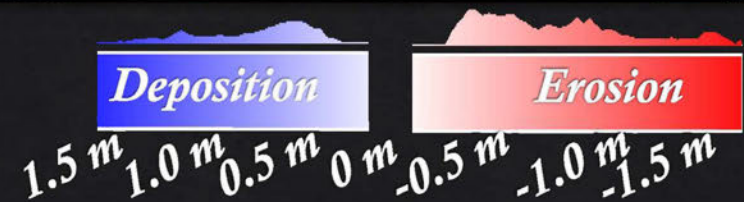
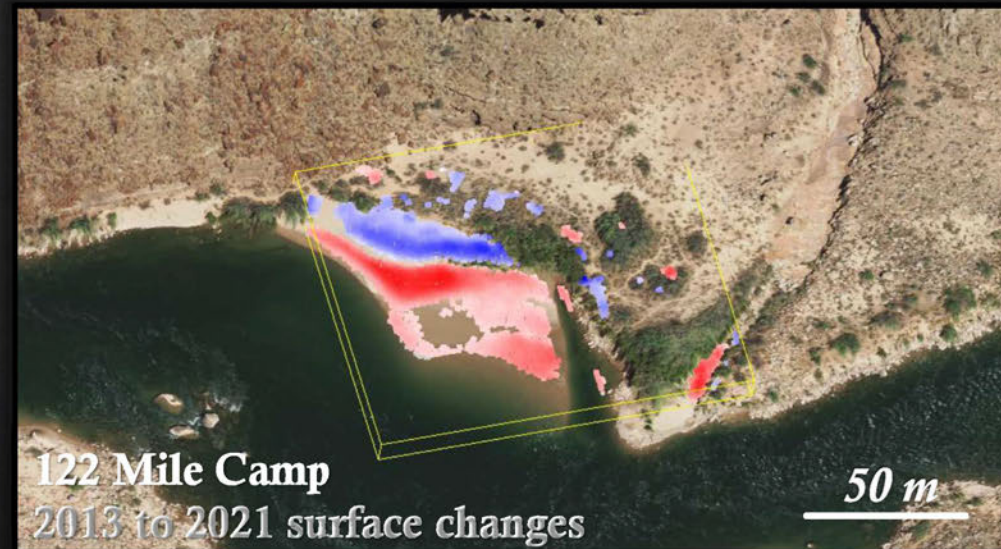
Key Points

1. Bistable source-bordering aeolian dunefields with active (bare) and inactive (vegetated) states occur along rivers under desert climates
2. Active to inactive state transition occurs when fluvial-sourced aeolian sediment supply reduced to dunes, especially in wetter climate
3. Morphodynamics show active to inactive transition coincides with more erosion despite greater vegetation and less aeolian sediment transport

Project L FY26/27 Science Activities

DSM change detection analysis for a continuous section of the river corridor

- Begin work on system-wide high-elevation sand metric
- 2021 topography useful baseline for post-fire landslide hazard program



An aerial photograph of a desert canyon. The canyon walls are steep and composed of light-colored, sandy soil with sparse, low-lying vegetation. A river flows through the bottom of the canyon, its water appearing dark green. The sky is a clear, pale blue. The text "Thank You" is overlaid in the upper center of the image.

Thank You

References:

Sankey, J.B., Bransky, N.D., Pigue, L.M., Kohl, K.A., and Gushue, T.M., 2025, Four-band image mosaic of the Colorado River corridor downstream of Glen Canyon Dam in Arizona, derived from the May 2021 airborne image acquisition: U.S. Geological Survey Data Report 1202,

Sankey, J.B., Bransky, N., Pigue, L., Kohl, K., and Gushue, T.M., 2024, Four Band Image Mosaic of the Colorado River Corridor in Arizona—2021, including Accuracy Assessment Data: U.S. Geological Survey data release, <https://doi.org/10.5066/P9BBGN6G>.

